Signals and Circuits

ERGN 35500

Logic gates

Web: https://www.tutorialspoint.com/computer_logical_organization/logic_gates.htm

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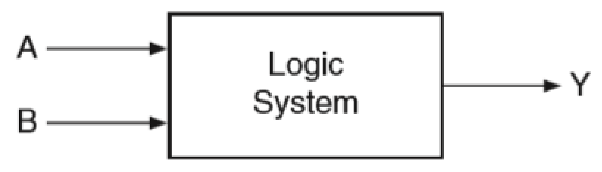
Gates

- The most basic digital devices are called gates.
- Gates got their name from their function of allowing or blocking (gating) the flow of digital information.
- A gate has one or more inputs and produces an output depending on the input(s).
- A gate is called a combinational circuit.
- Three most important gates are: AND, OR, NOT.
- Other logic gates that are derived from these basic gates are the NAND gate, the NOR gate, the EXCLUSIVEOR gate and the EXCLUSIVE-NOR gate.

Digital Logic



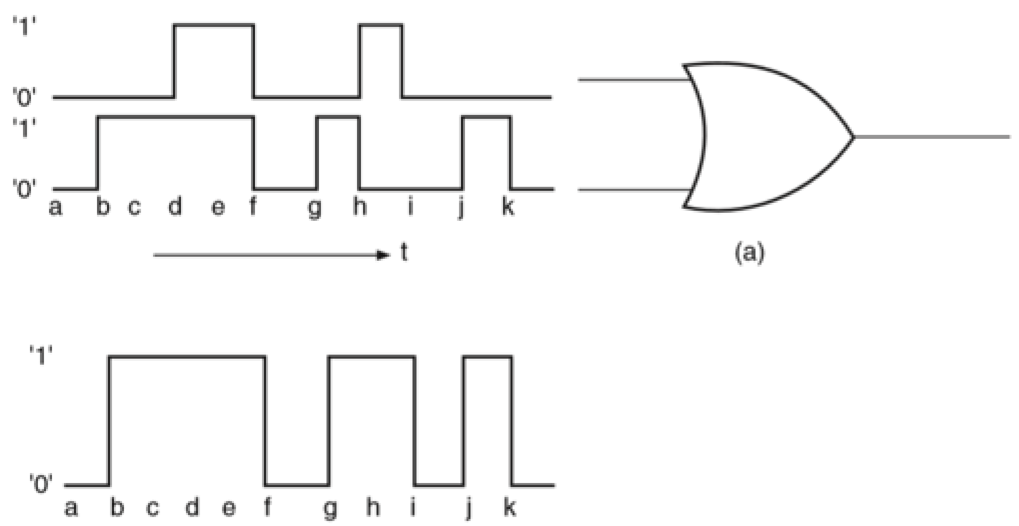
(a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

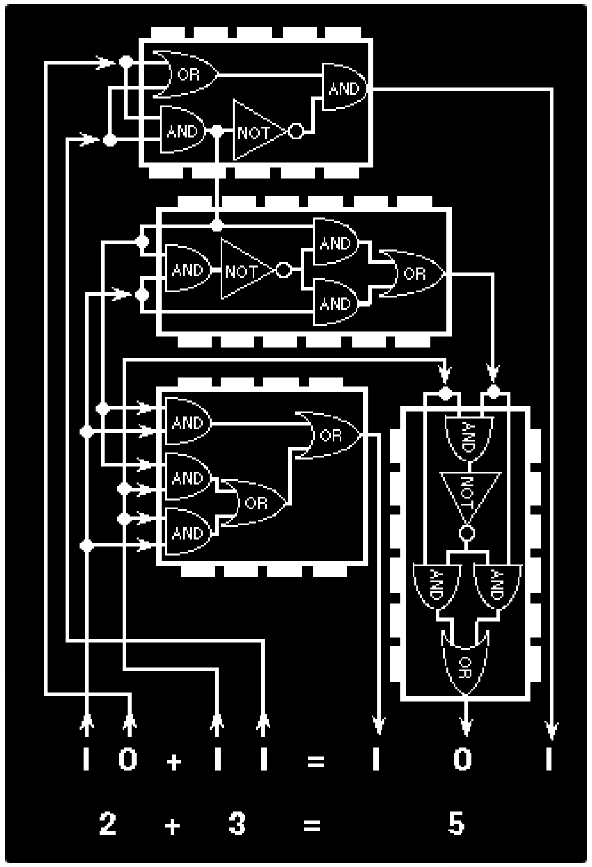
(b)

True table

Two-input logic system



Signal processing with digital gate



Examples of logic gates for calculation

https://www.quora.com/How-do-I-make-a-calculator-using-logic-gates

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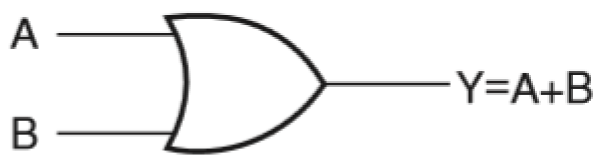
Digital Logic

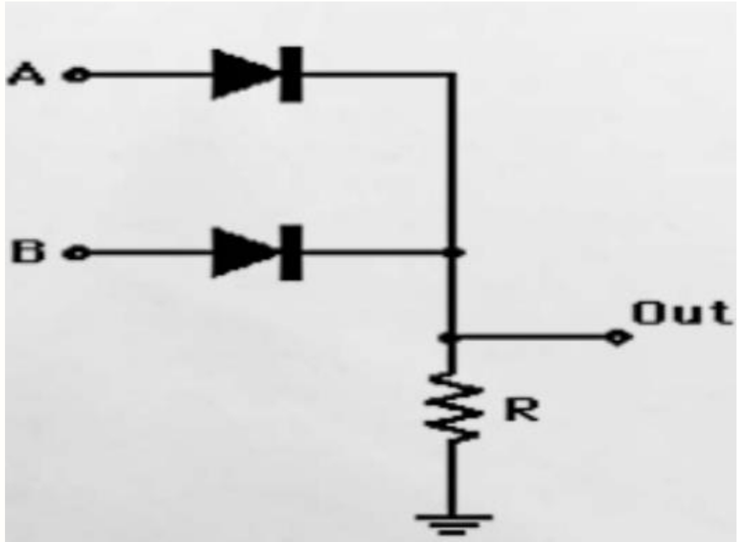
- **OR gate**

$Y = A + B$



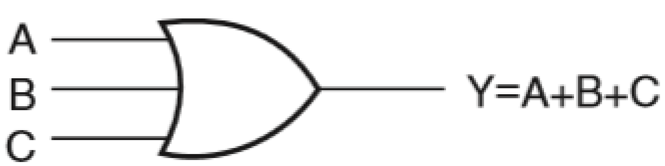
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	1

Two-input OR gate



Physical example

Y=A+B+C

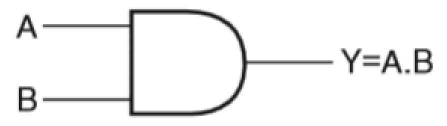


A	B	C	Y
0	0	0	0
0	0	1	1
0	1	0	1
0	1	1	1
1	0	0	1
1	0	1	1
1	1	0	1
1	1	1	1

Three-input OR gate

Digital Logic

- **AND gate**

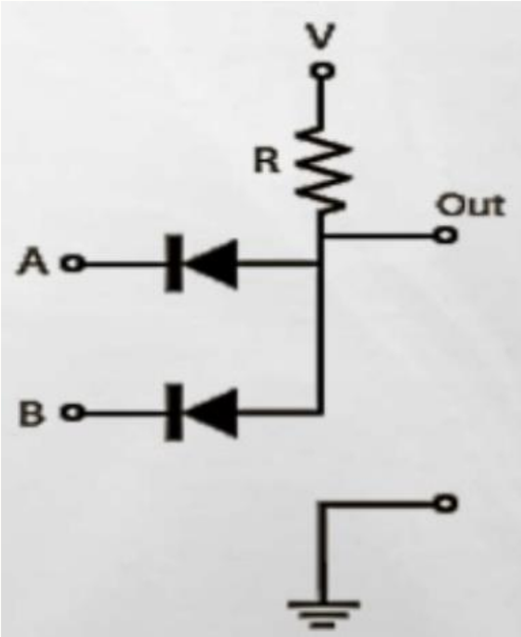


(a)

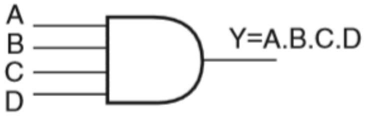
A	B	Y
0	0	0
0	1	0
1	0	0
1	1	1

(b)

Two-input AND gate



Physical example



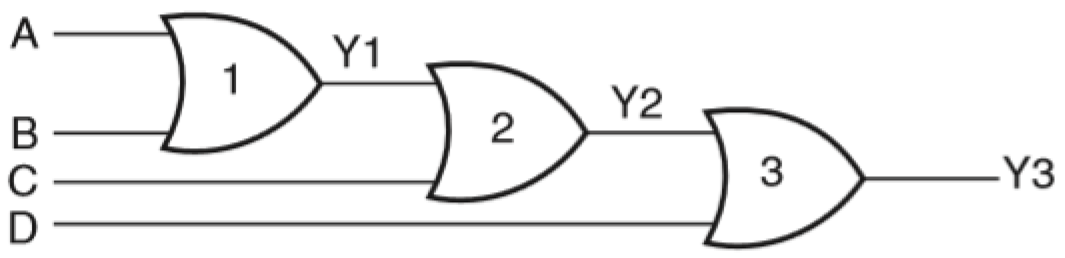
A	B	C	D	Y
0	0	0	0	0
0	0	0	1	0
0	0	1	0	0
0	0	1	1	0
0	1	0	0	0
0	1	0	1	0
0	1	1	0	0
0	1	1	1	0
1	0	0	0	0
1	0	0	1	0
1	0	1	0	0
1	0	1	1	0
1	1	0	0	0
1	1	0	1	0
1	1	1	0	0
1	1	1	1	1

Four-input AND gate

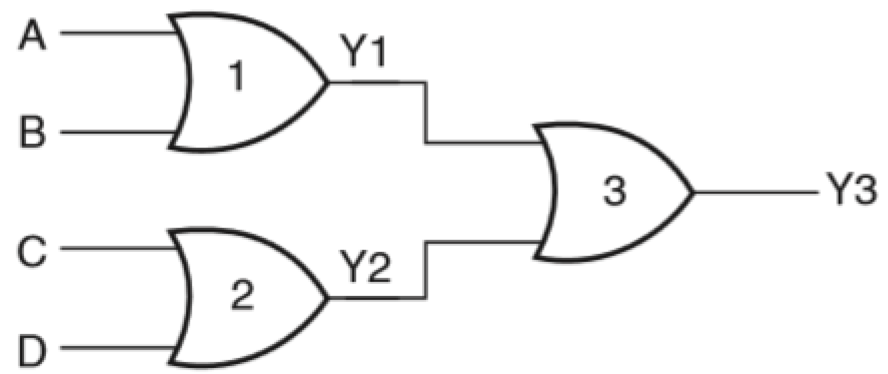
Digital Logic

Think

Do the following logic gates have the same true table (Y3 as the final output)?



(a)

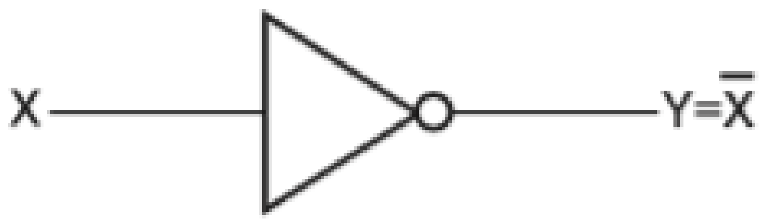


(b)

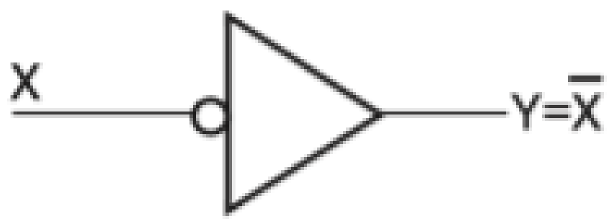
A	B	C	D	Y3
0	0	0	0	0
0	0	0	1	1
0	0	1	0	1
0	0	1	1	1
0	1	0	0	1
0	1	0	1	1
0	1	1	0	1
0	1	1	1	1
1	0	0	0	1
1	0	0	1	1
1	0	1	0	1
1	0	1	1	1
1	1	0	0	1
1	1	0	1	1
1	1	1	0	1
1	1	1	1	1

Digital Logic

- **NOT gate**



(a)



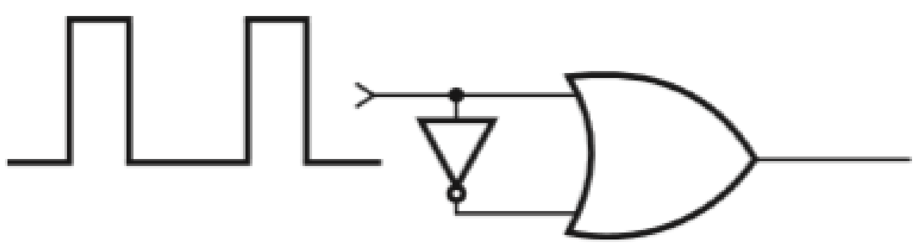
(b)

X	Y
0	1
1	0

Digital Logic

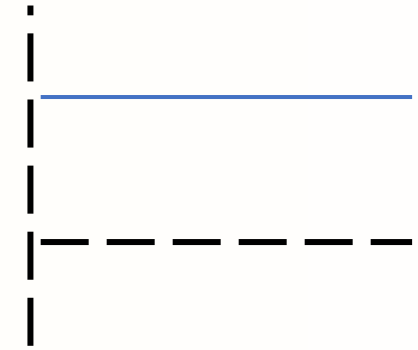
Practice

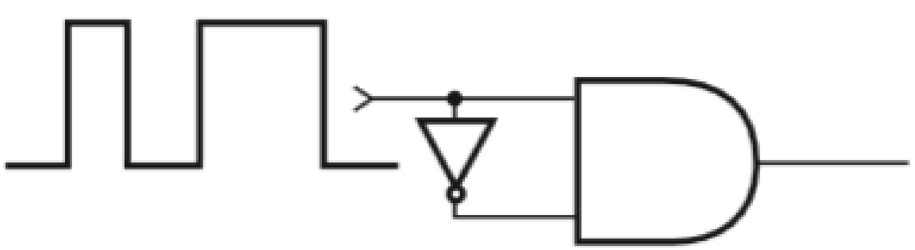
Given the input digital signal and the logic gates, draw the output signal



(a)

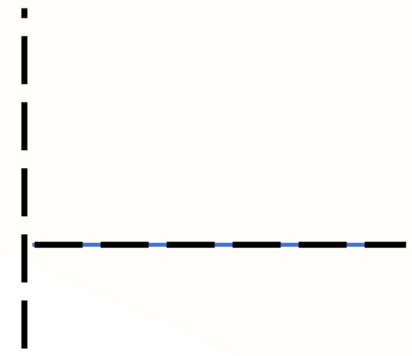
X	Y
0	1
1	1





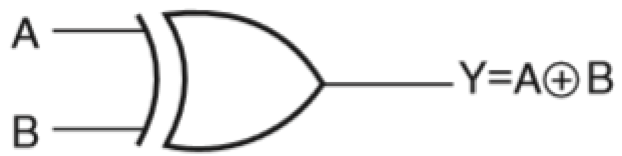
(b)

X	Y
0	0
1	0



Digital Logic

EXLUSIVE-OR Gate



(a)

A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

(b)

As can be seen from the truth table, the output of an EX-OR gate is a logic ‘1’ when the inputs are unlike and a logic ‘0’ when the inputs are like

EX-Or (XOR/EOR) gate

It is equivalent to a combination of AND, OR, and NOT gates

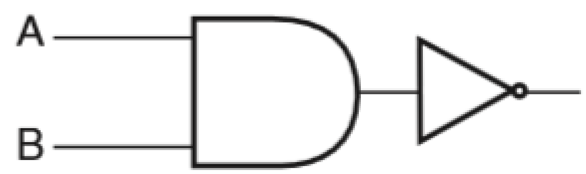
$$Y = A \oplus B = \overline{A}B + A\overline{B}$$

Digital Logic

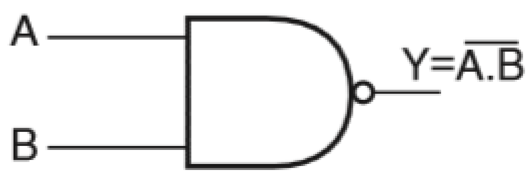
NAND gate

NAND stands for NOT AND

$$Y = \overline{A.B}$$



(a)



(b)

A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

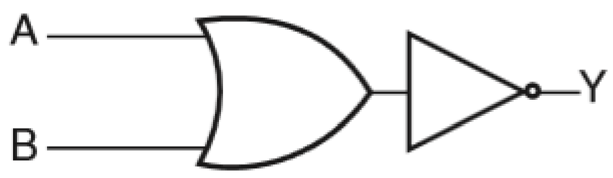
(c)

The output of a NAND gate is a logic ‘0’ when all its inputs are a logic ‘1’.

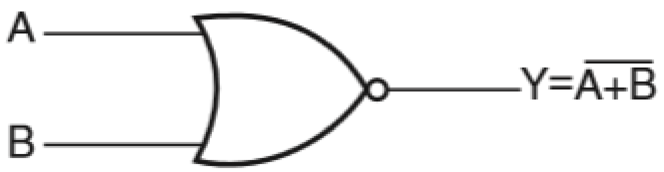
Digital Logic

NOR gate

NOR stands for NOT OR



(a)



(b)

The output of a NOR gate is a logic ‘1’ when all its inputs are logic ‘0’

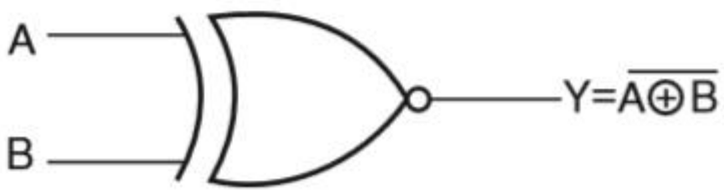
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0

(c)

Digital Logic

EXCLUSIVE-NOR gate

EX-NOR stands for NOT of EX-OR



(a)

A	B	Y
0	0	1
0	1	0
1	0	0
1	1	1

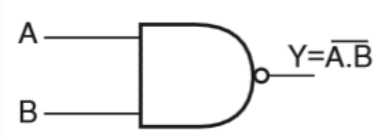
(b)

$$Y = (\overline{A \oplus B}) = (A.B + \overline{A}.\overline{B})$$

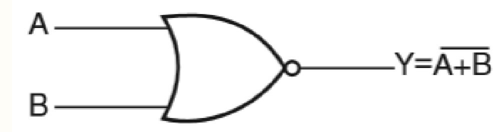
The output of a two-input EX-NOR gate is a logic ‘1’ when the inputs are like and a logic ‘0’ when they are unlike. In general, the output of a multiple-input EX-NOR logic function is a logic ‘0’ when the number of 1s in the input sequence is odd and a logic ‘1’ when the number of 1s in the input sequence is even including zero. That is, an all 0s input sequence also produces a logic ‘1’ at the output

Digital Logic

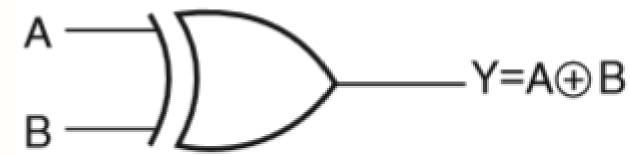
NOTE:



A	B	Y
0	0	1
0	1	1
1	0	1
1	1	0

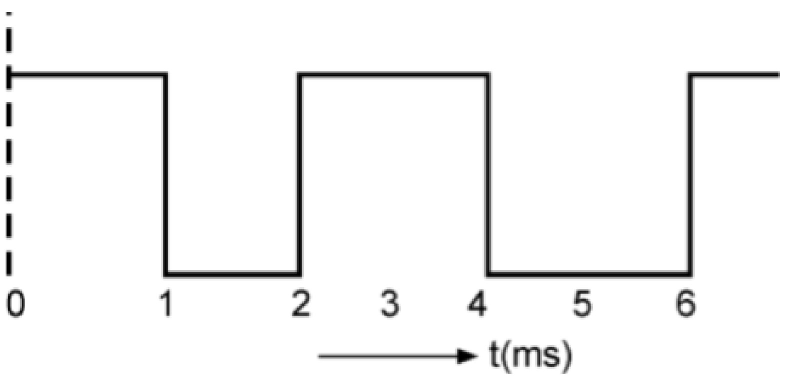


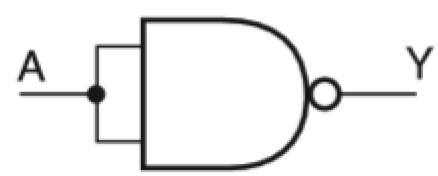
A	B	Y
0	0	1
0	1	0
1	0	0
1	1	0



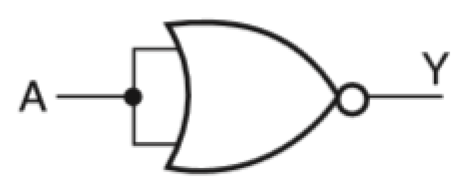
A	B	Y
0	0	0
0	1	1
1	0	1
1	1	0

Practice





(a)



(b)

(c)